Recommended Approaches to General Service Lighting Efficiency Standards

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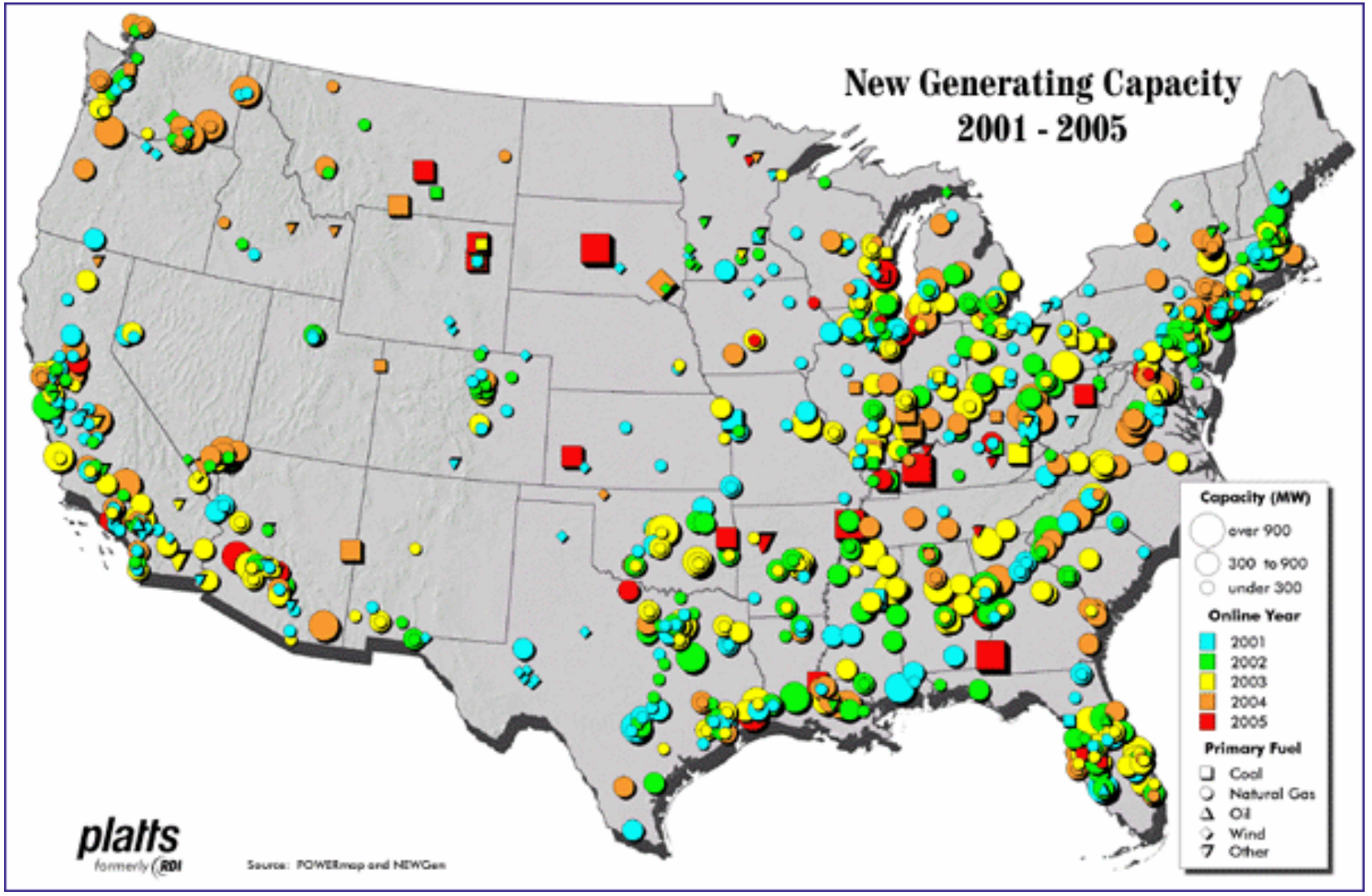
Key Topics Addressed

- What has changed since California last regulated general service incandescent lamps?
  - Climate imperative
  - Improved technology
  - International will by policymakers to act in concert
- Downsides and pitfalls of the “Tier 2” standards approach
  - Loopholes
  - More focus on power than efficiency – allows dimmer products
- Establishing a conceptual basis for Tiers 3 and 4
  - Smooth continuous standards curve applying equal pressure to improve efficiency across the board
- New labeling approaches and incentive approaches
  - Arm consumers with more efficiency information
  - Make inefficient products more expensive and efficient products less expensive

New U.S. Power Plants by Type, Size and Year of Construction



How Much Energy Are General Service Incandescent Lamps Consuming?

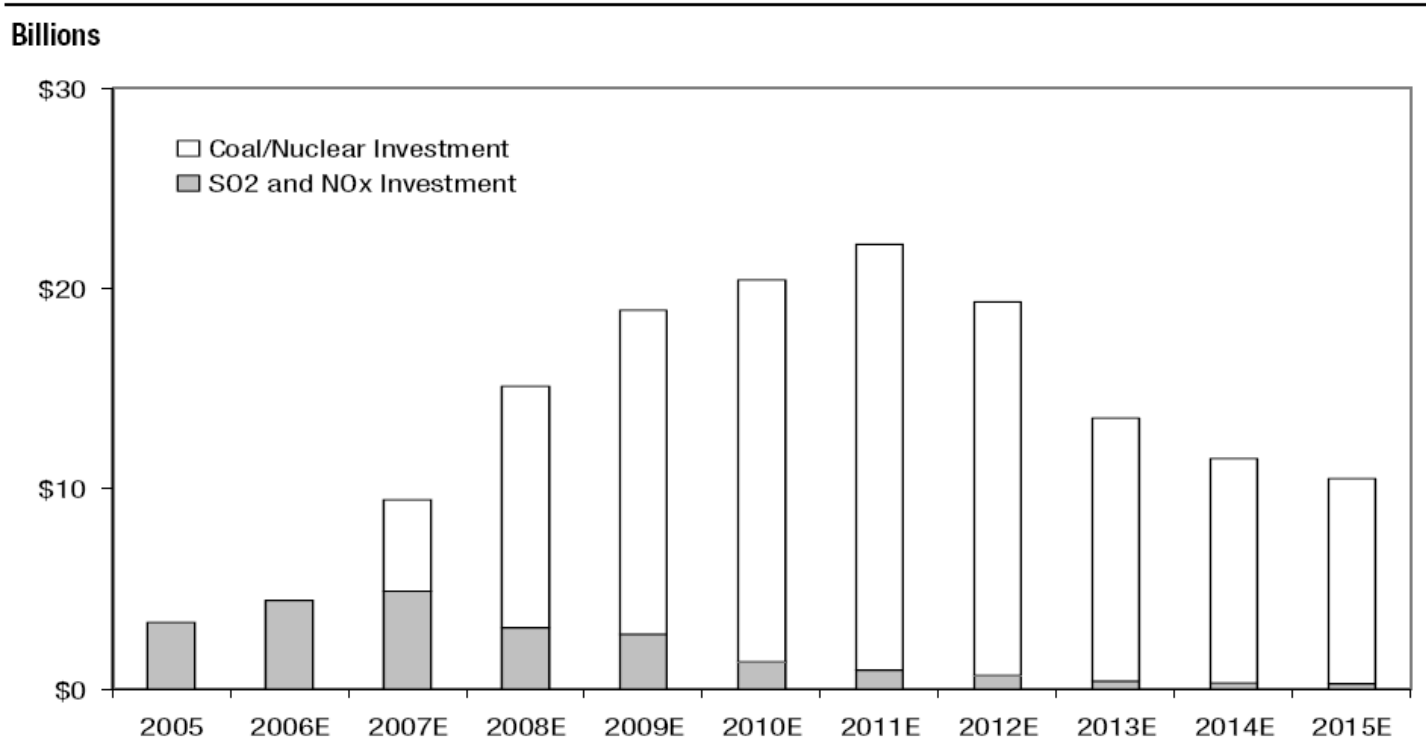
- DOE estimated that there were 3.9 billion general service incandescent lamps in use nationwide in 2001 at an average power use of 65 watts operating for 2.4 hours/day (57 kWh/year).
- Total energy use of general service incandescent lamps: about 222 billion kWh/year – equivalent to the output of 67 new base load coal plants.
- Assume this has dropped to 200 billion kWh/year and 60 coal plants due to rapidly rising CFL sales.

How Much Energy Can New Standards Save?

- New technologies are making it possible to cut the power use of current incandescents by 25 to 50% and extend lamp life to 2,000 to 3,000 hours (3 to 4 years).
- This saves about 16 to 32 average watts or 32 to 96 average lifetime kWh per new bulb. These savings would allow incandescent lamps to reach retail prices of $3 to $10 apiece and still be cost effective.
- National savings potential after full stock replacement = 25 to 50% of 200 billion kWh/year or 50 to 100 billion kWh/year.
- This equals 15 to 30 of the 153 new coal-fired power plants proposed in the U.S. right now – one of the largest and most cost-effective single greenhouse gas reduction policy measures currently under consideration.

$125 billion in U.S. capital expenditures on new power generation facilities, including nuclear and "cleaner" coal, through 2015.

Figure 41. U.S. Generation and Environmental Expansionary Capital Spending Outlook



Source: Citigroup Investment Research, Energy Information Administration, industry reports

Q: How much efficiency could we buy with $125 billion?

A: Even at twice the cost of today's utility programs, it would buy 2 trillion kWh – about half of current U.S. electricity use

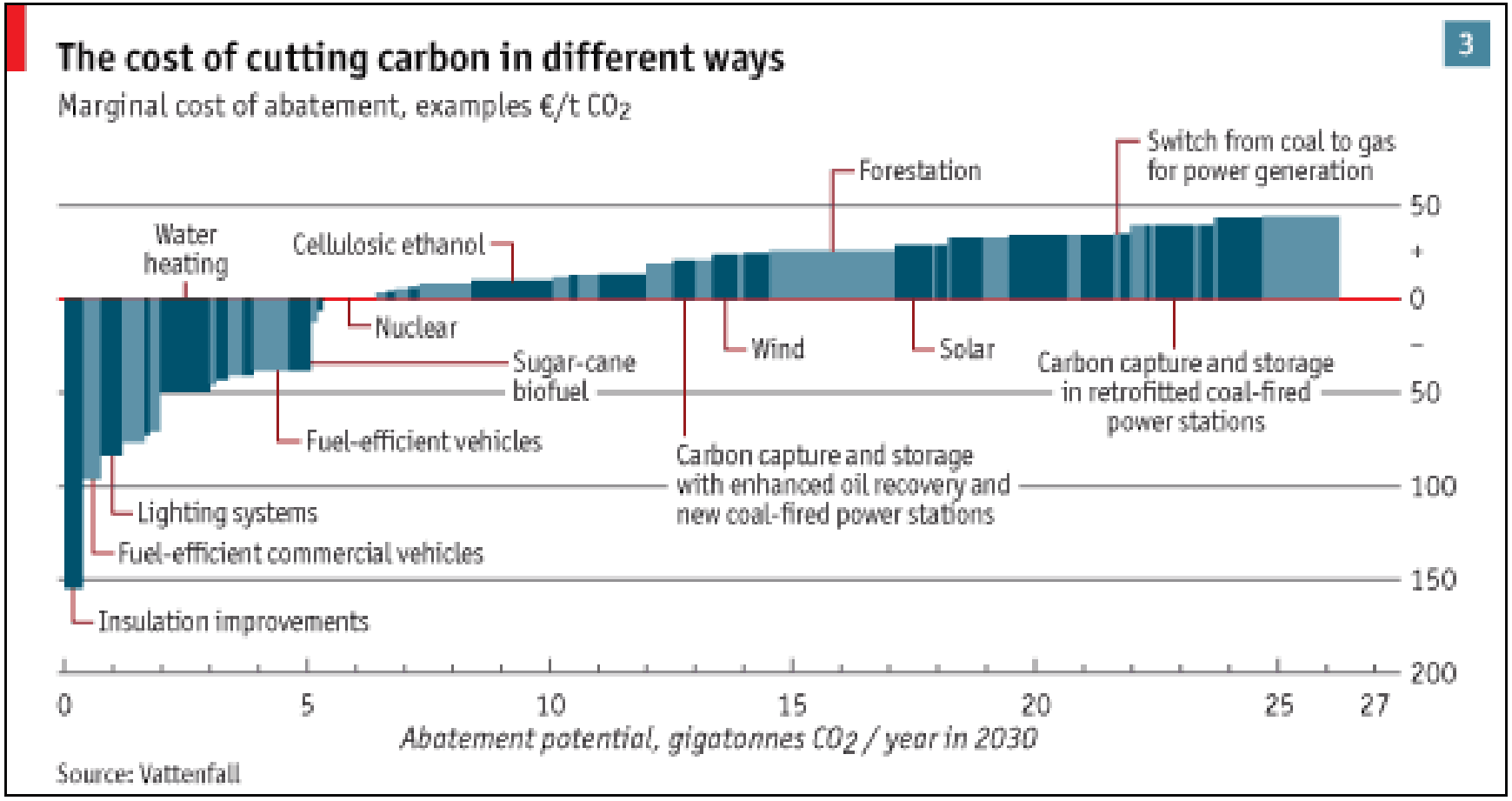
Source: Citigroup, *Climatic Consequences: Investment Implications of a Changing Climate*, 2007.

What's Changed Since the Last Two Rounds of California Lamp Efficiency Standards? The Urgency of Addressing Climate Change

"From a business perspective, the need for mandatory federal policy in the United States to manage greenhouse gases is both urgent and real. In my view, voluntary actions will not get us where we need to be. Until business leaders know what the rules will be—which actions will be penalized and which will be rewarded—we will be unable to take the significant actions the issue requires."

--Jim Rogers, CEO, Duke Energy

Excerpt from *The Economist*: One European Utility's Effort to Rank Options on a Cost of Saved Carbon Basis



Assessment of California Tier 1 and Tier 2 Standards Impacts So Far

- Standards successfully established a precedent for states to regulate general service incandescent lamp efficiency, helping to kick-start other policy action worldwide
- Tier 1 standards have been in effect since January 2006 – still no data from manufacturers in the CEC database to assess product changes and overall compliance rates
- Exemptions for modified spectrum, vibration resistant, three-way, and high- and low-wattage products reduced effectiveness and standards coverage
- Wattage plateaus and wide lumen bins make Tier 2 simple to understand, but lead to gaming strategies like selling dimmer, less efficient lamps to meet the power targets

Shift in Product Offerings from a Major Manufacturer to Meet CA Standards

Compliant

Energy-Saving Products

Watts	Light Output (lumens)	Efficacy (lumens/W)	Life (hrs)
34	375	11.0	1500
52	715	13.8	1000
67	1040	15.5	750
90	1450	16.1	750

Non-Compliant

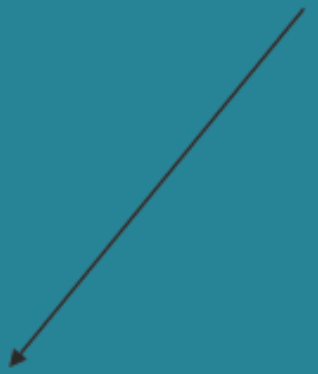
Long Life Products

Watts	Light Output (lumens)	Efficacy (lumens/W)	Life (hrs)
40	390	9.8	3000
60	770	12.8	2000
75	1035	13.8	1500
100	1530	15.3	1500

Non-Compliant

Standard Soft White Products

Power (W)	Light Output (lumens)	Efficacy (lumens/W)	Life (hrs)
40	465	11.6	1500
60	850	14.2	1000
75	1170	15.6	750
100	1690	16.9	750



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90	1450	16.1	750

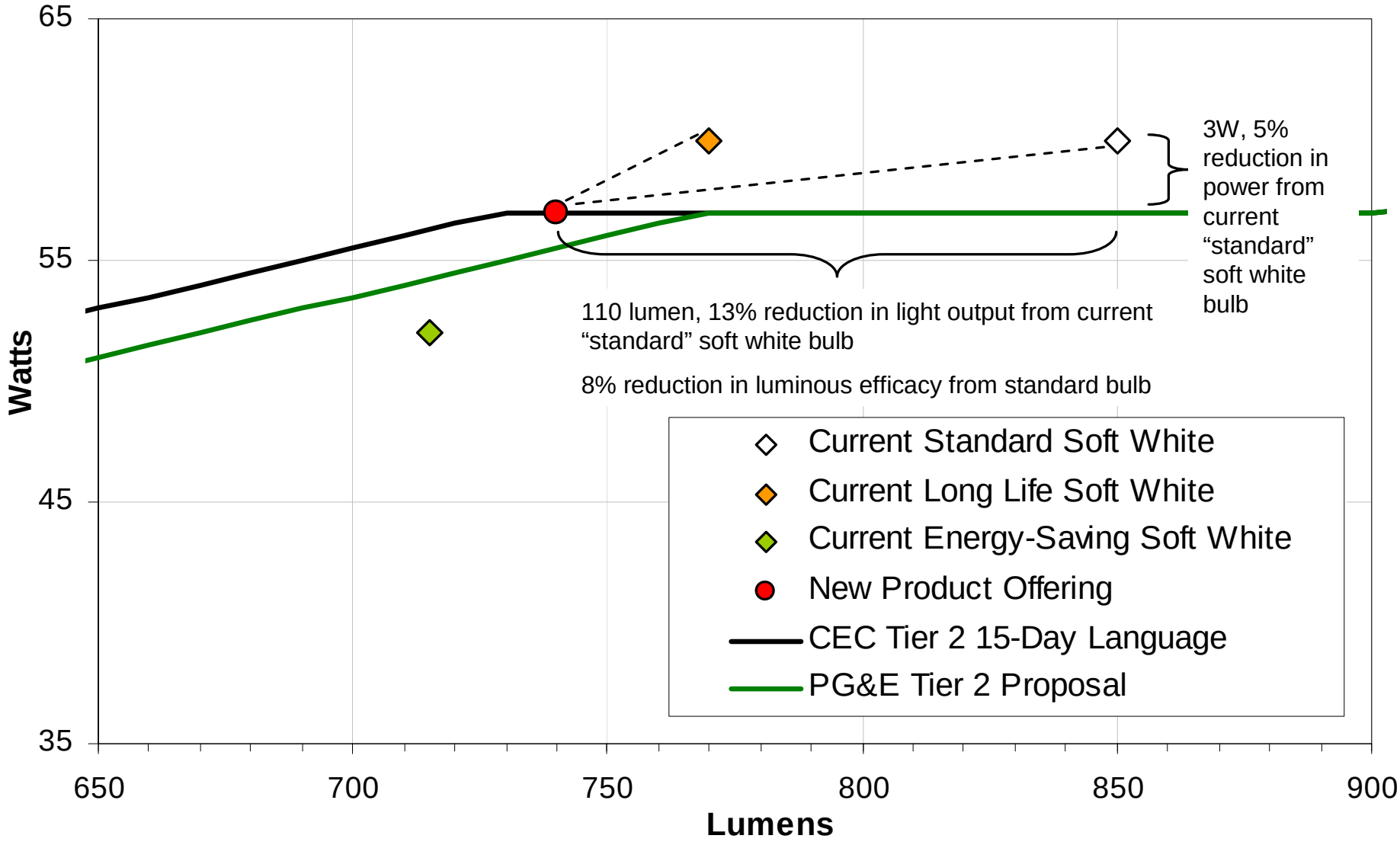
Compliant

New Product to Meet CA Standards

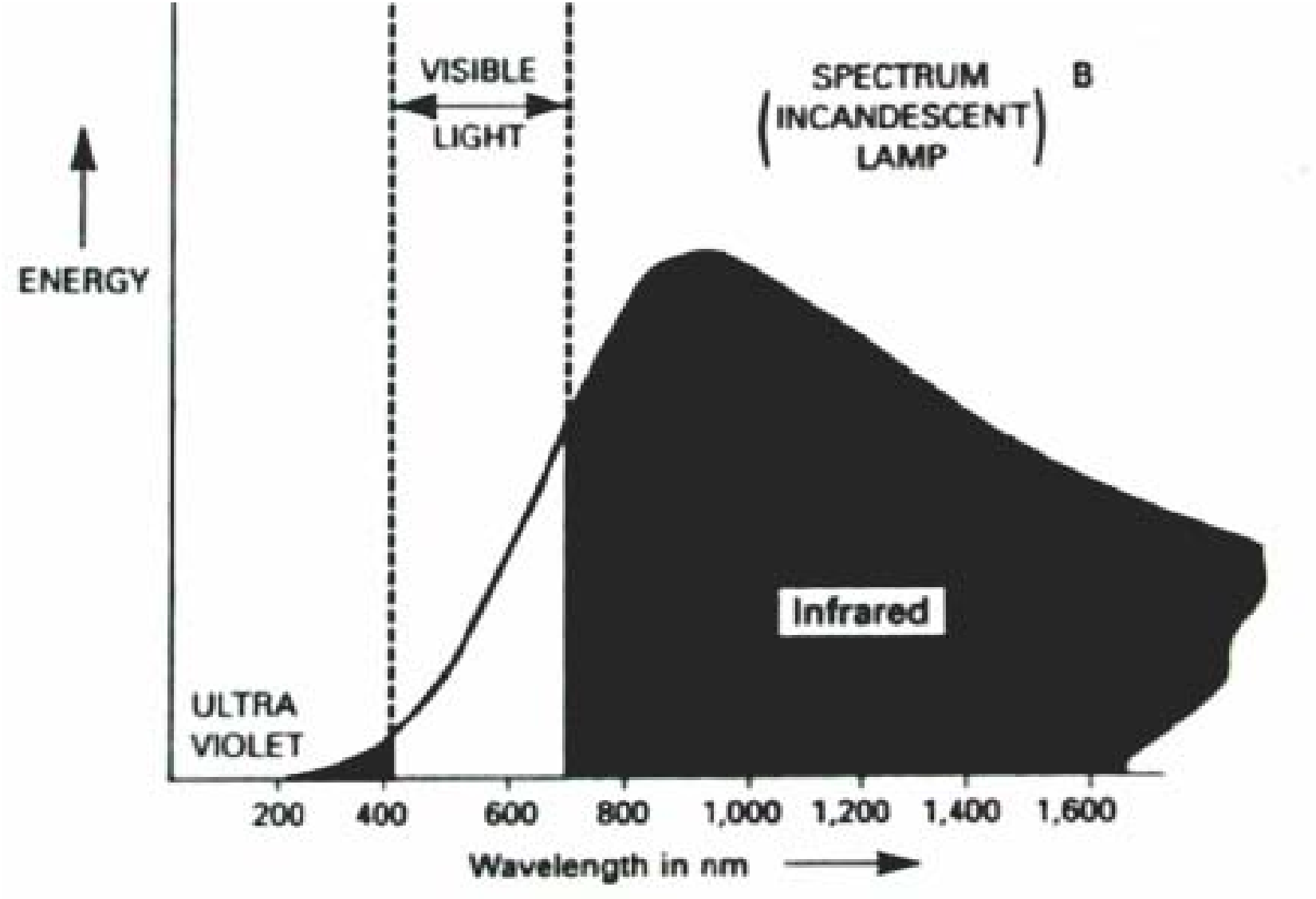
Watts	Light Output (lumens)	Efficacy (lumens/W)	Life (hrs)
38	410	10.8	2250
57	740	13.0	1500
71	1020	14.4	1125
95	1500	15.8	1125

Compliant

COMPARISON OF NEW PRODUCTS FROM MAJOR INCANDESCENT LAMP MANUFACTURER



Big Opportunity to Improve Incandescent Efficiency



Technologies for Improving Incandescent Efficiency

- Halogen, krypton, or xenon fill gas instead of argon to better insulate the filament
- Reduce input voltage in a highly efficient way – more current for a given wattage to achieve greater filament heating at lower wattage
- Infrared reflective coatings – bounce heat back onto the filament while allowing visible light to pass through
- Selective emitters – new filament technologies intended to outperform coiled tungsten in efficiency and lamp life:
  - Ceramic filaments (hafnium carbide)
  - Photonic lattices
  - DOE research with Foster-Miller on “super-emitter” tungsten lamps
  - Others?

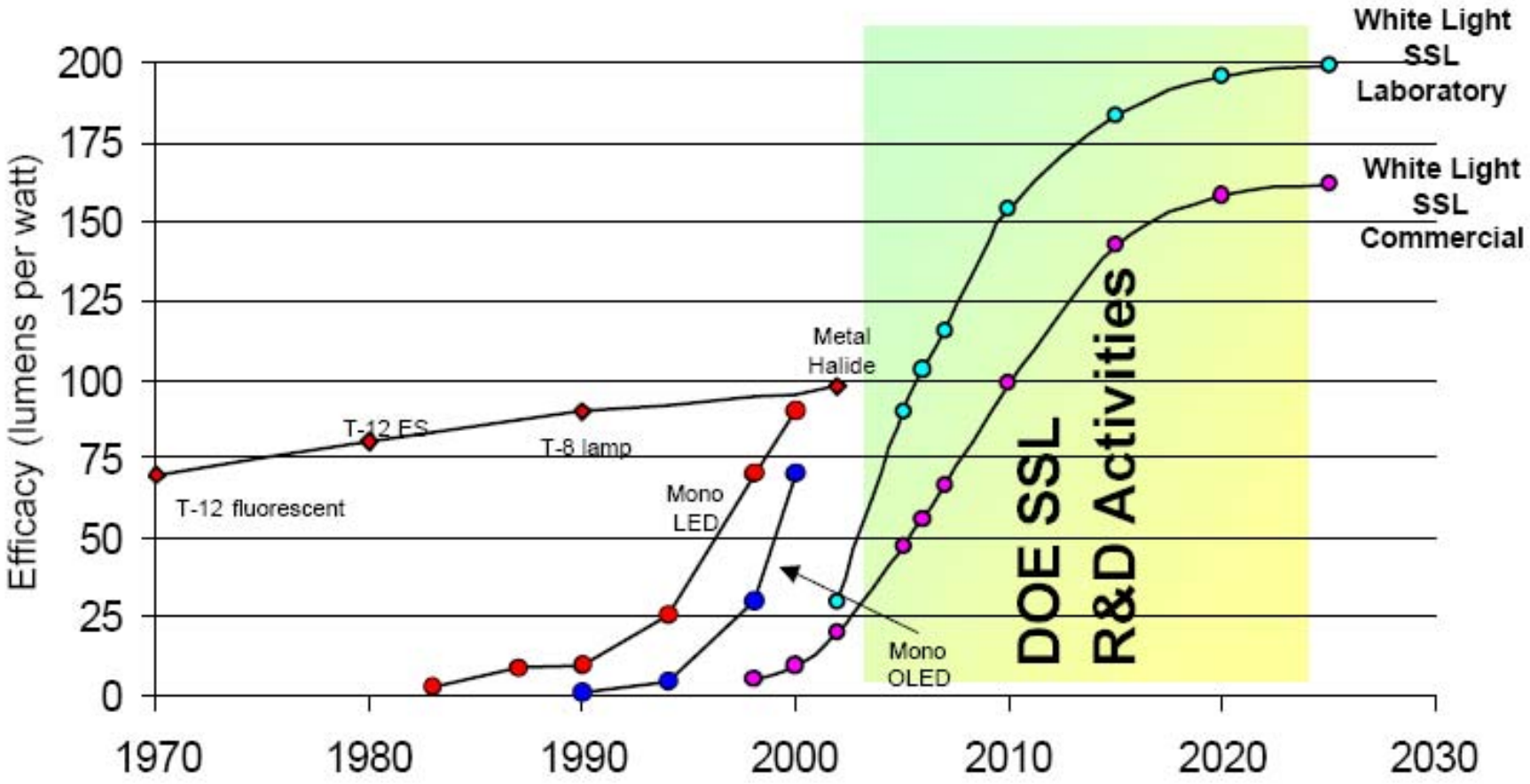
New Philips Eco-Boost/Edore/MasterClassic Low Voltage Halogen – Roughly Double the Efficiency and Triple the Lifetime

Savings result from halogen fill gas, low voltage/high current operation, and infrared-reflective coating on inner quartz capsule

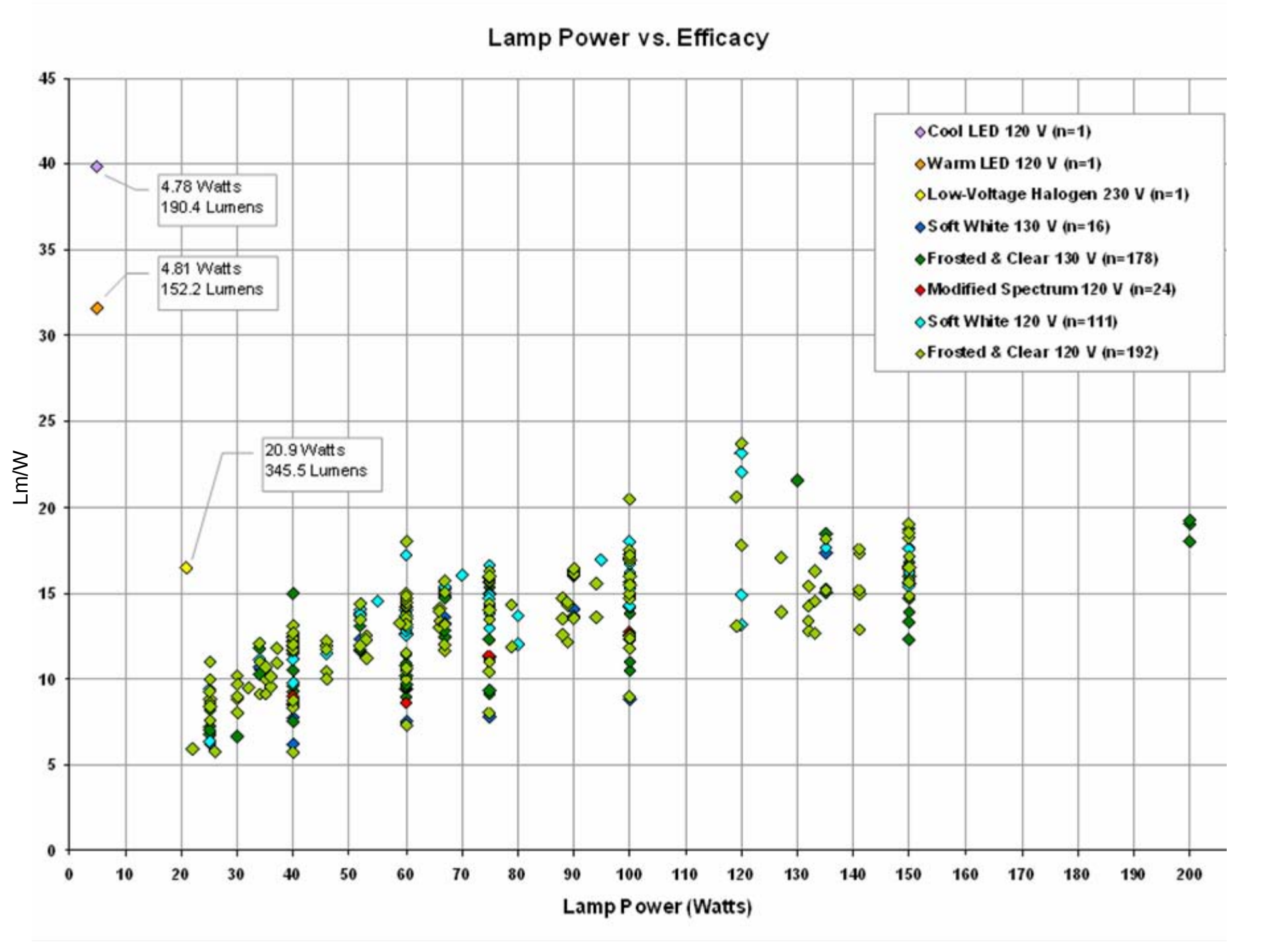
230 Volt sample of the new Philips halogen bulb:

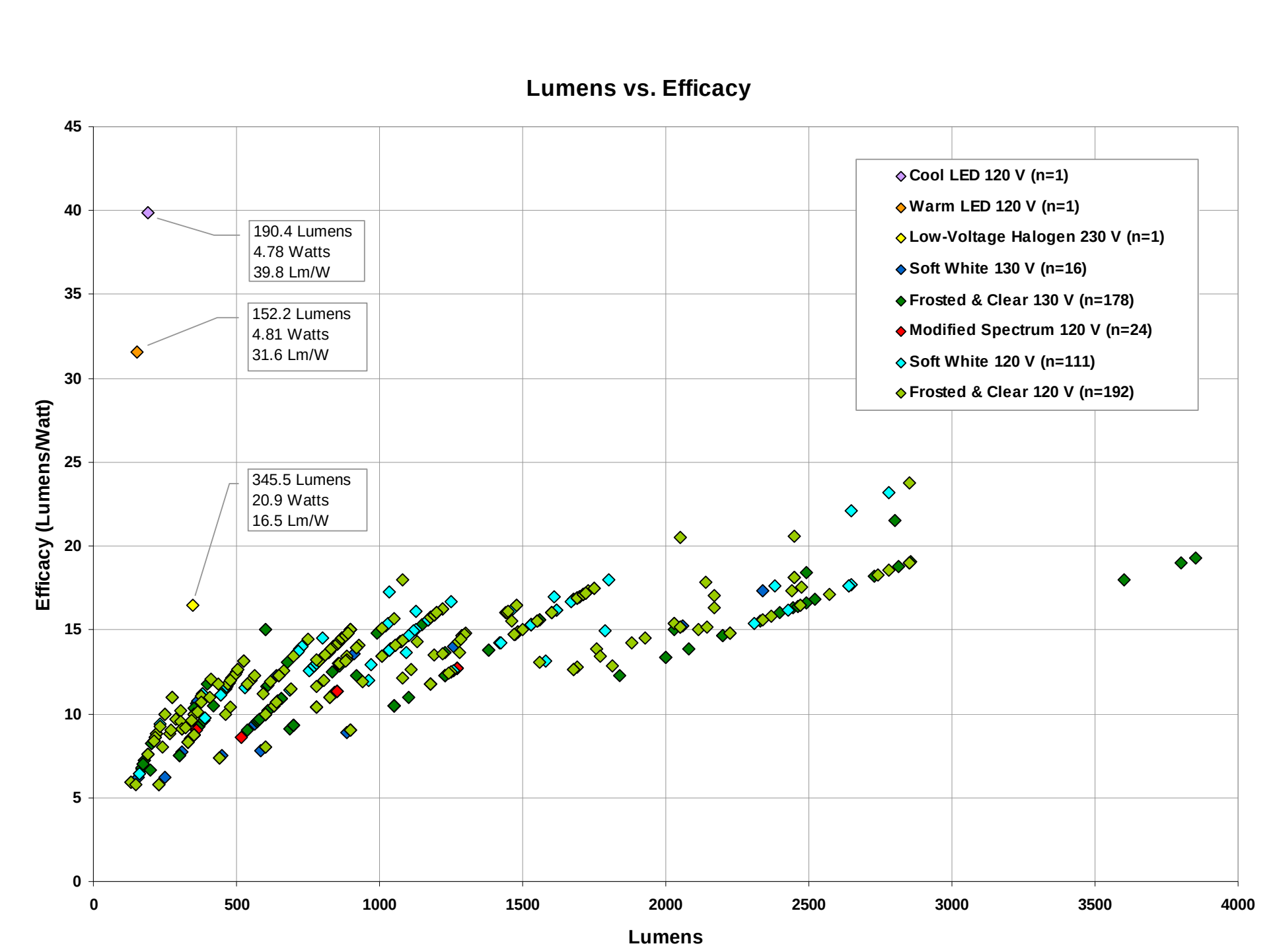
- Available in 20 and 30 watt versions with 3,000 hour lifetime to replace 40 and 60 watt incandescents
- 315 lumens and 20 watts = 15.7 lm/watt: ratings very close to U.S. lab measurements of 16.5 lm/watt

Accelerated R&D for White Light SSL



SSL Laboratory and Commercial Curves, revised September 2004


Lamp Power vs. Efficacy
Cool LED 120 V (n=1)
Warm LED 120 V (n=1)
Low-Voltage Halogen 230 V (n=1)
Soft White 130 V (n=16)
Frosted & Clear 130 V (n=178)
Modified Spectrum 120 V (n=24)
Soft White 120 V (n=111)
Frosted & Clear 120 V (n=192)
4.78 Watts
190.4 Lumens
4.81 Watts
152.2 Lumens
20.9 Watts
345.5 Lumens
Lm/W
Lamp Power (Watts)
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200


Lumens vs. Efficacy
Efficacy (Lumens/Watt)
Lumens
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500
2000
2500
3000
3500
4000
190.4 Lumens
4.78 Watts
39.8 Lm/W
152.2 Lumens
4.81 Watts
31.6 Lm/W
345.5 Lumens
20.9 Watts
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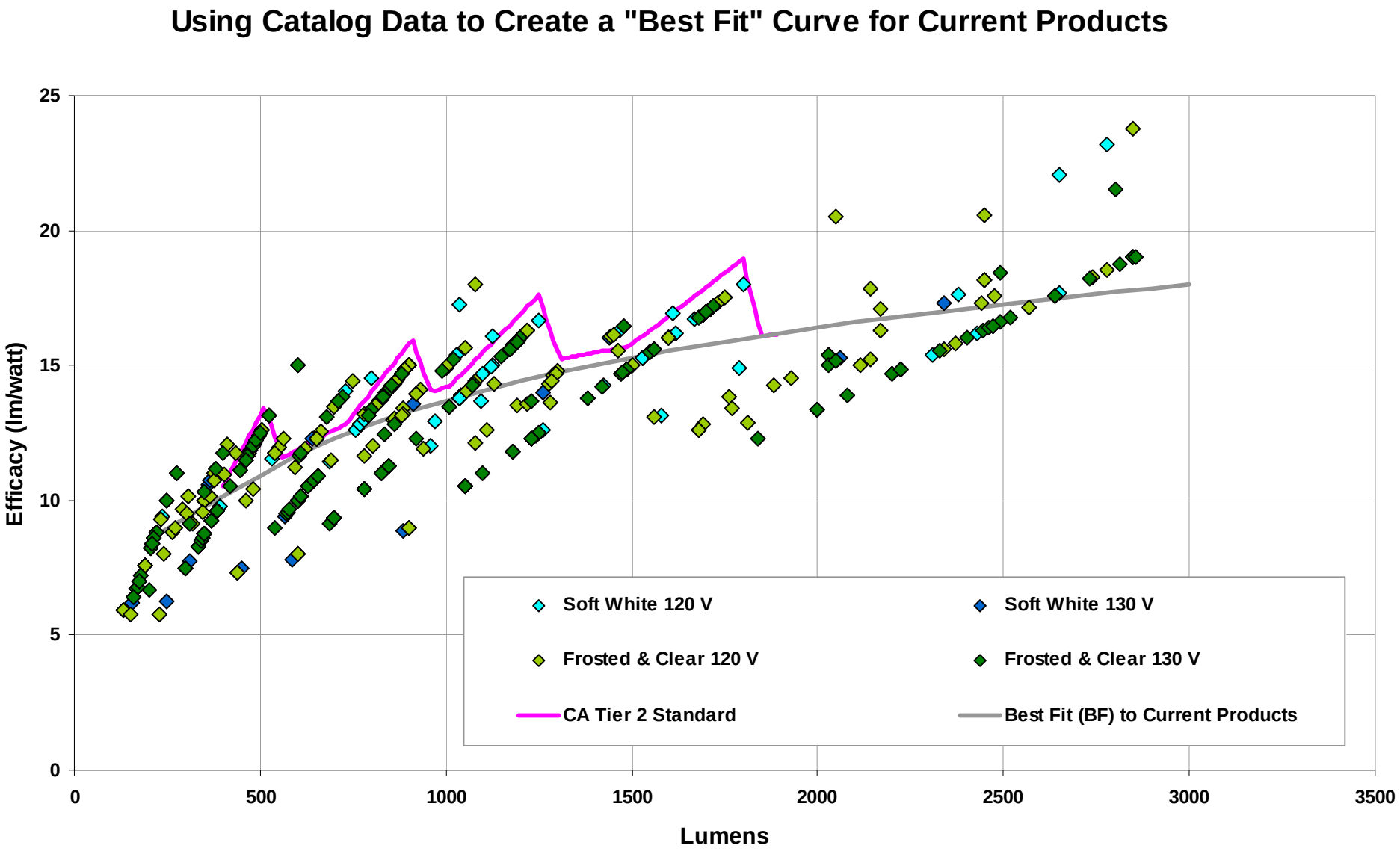
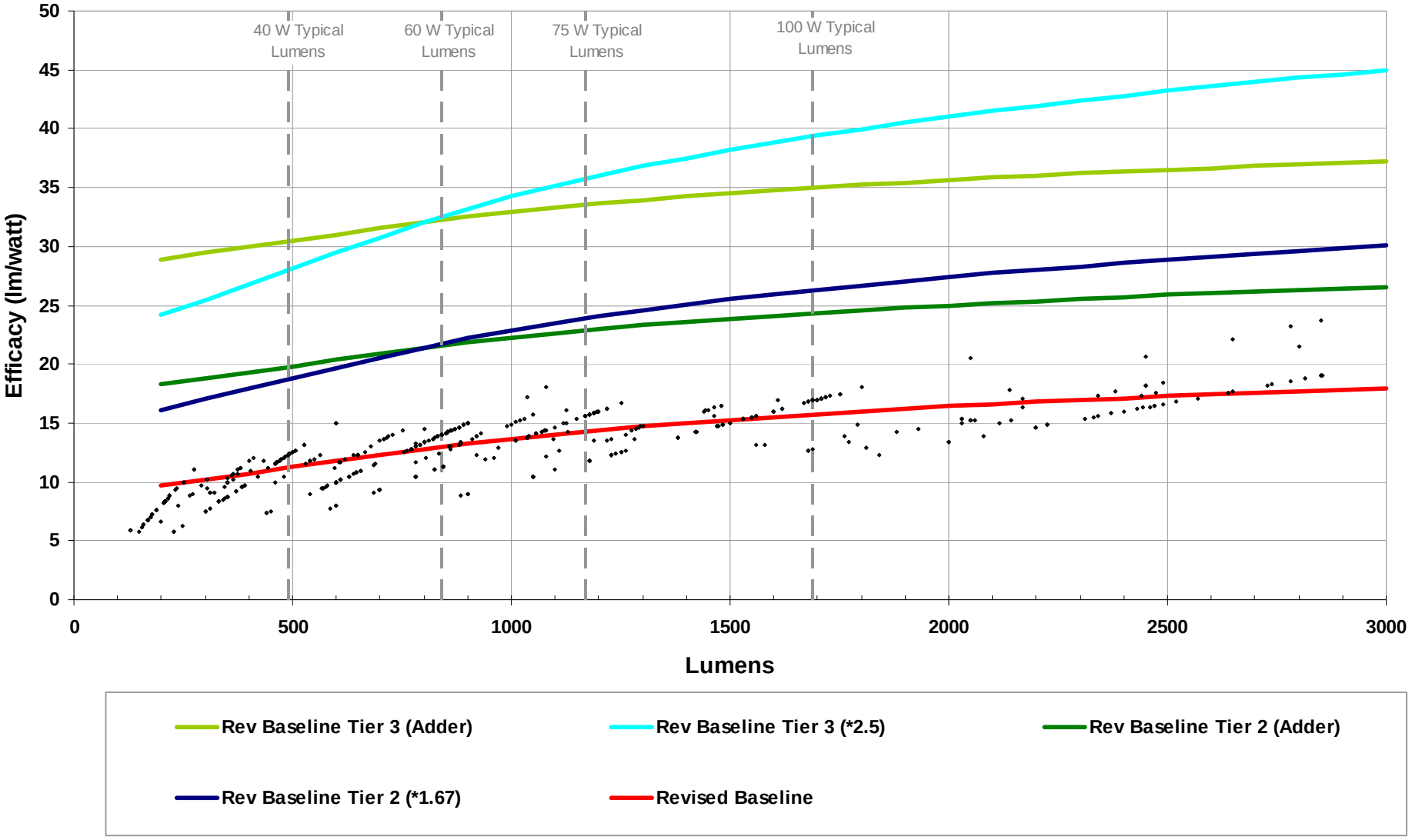
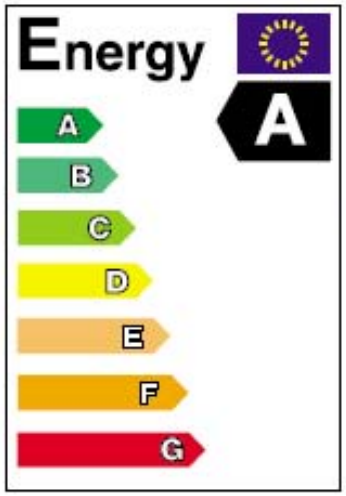

Using Catalog Data to Create a "Best Fit" Curve for Current Products
Efficacy (lm/watt)
0
5
10
15
20
25
0
500
1000
1500
2000
2500
3000
3500
Lumens
Soft White 120 V
Soft White 130 V
Frosted & Clear 120 V
Frosted & Clear 130 V
CA Tier 2 Standard
Best Fit (BF) to Current Products

Standards Can Use Efficiency Multipliers or Adders to Today's Baseline



A Philosophy of Efficiency: Principles from the ACEEE 2006 Summer Study

1. Products should convert power efficiently.
2. Products should store and retrieve energy efficiently.
3. Products should closely match power consumption to the level of service or function being performed.
4. Devices should clearly and consistently communicate their operating state to users and other devices to which they are networked.
5. Products should be shipped with power-saving features enabled as the default.
6. Manufacturers should test the overall energy efficiency of their products according to standard test procedures and disclose that information on product packaging and public websites.
7. Product capability or performance should never be marketed or promoted by the manufacturer or retailer in terms of power consumed.



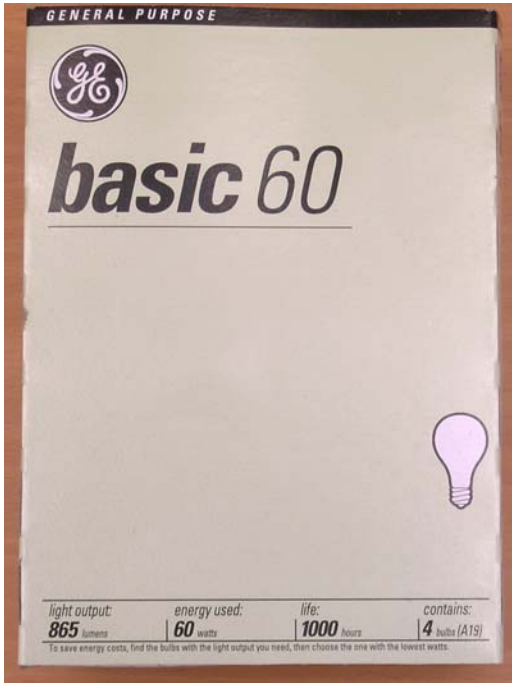
Energy label information

As part of the European Union Energy Label guidelines, all domestic light bulbs are assigned an energy efficiency class. This rates from Class A, which represents most efficient to G, which is least efficient. This energy label can be found on every light bulb pack and on many domestic appliances.

Classes E and F - standard incandescent light bulbs are the least efficient alternatives.

Class D - mains voltage halogen bulbs usually fall into this category.

Classes A and B - energy savers fall in to these categories. They are the most efficient type of light bulb and use up to 80% less energy than standard light bulbs.


GENERAL PURPOSE
basic 60
light output: 865 lumens
energy used: 60 watts
life: 1000 hours
contains: 4 bulbs (A19)
To save energy costs, find the bulbs with the light output you need, then choose the one with the lowest watts.


GENERAL PURPOSE
soft white 60
regular, everyday light™
QUALITY OF LIGHT SCALE
soft white
regular soft light
reveal®
premium enhanced, vivid light
edison™
exceptional rich, bright light
light output: 840 lumens
energy used: 60 watts
life: 1000 hours
contains: 4 bulbs (A19)


Save $1.60 in Energy Costs*
Lightstyles for Lifestyles™
Soft White Light Bulbs
MISER
Provides Nearly the Same Light as 60 Watt, Avg. Lumens 840, Avg. Life 1000 hours
Light Output 800 LUMENS
Energy Used 55 WATTS
Life 1000 HOURS
Energy Saving Light 55 WATTS
4 Bulbs
To save energy costs, find the bulbs with the light output you need, then choose the one with the lowest watts.
*See Back For Details


Soft White Light Bulbs
2 TIMES LONGER LIFE
than our standard bulb*
Light Output 780 LUMENS
Energy Used 60 WATTS
Life 2000 HOURS
Soft Pleasing Light 60 WATTS
4 Bulbs
To save energy costs, find the bulbs with the light output you need, then choose the one with the lowest watts.

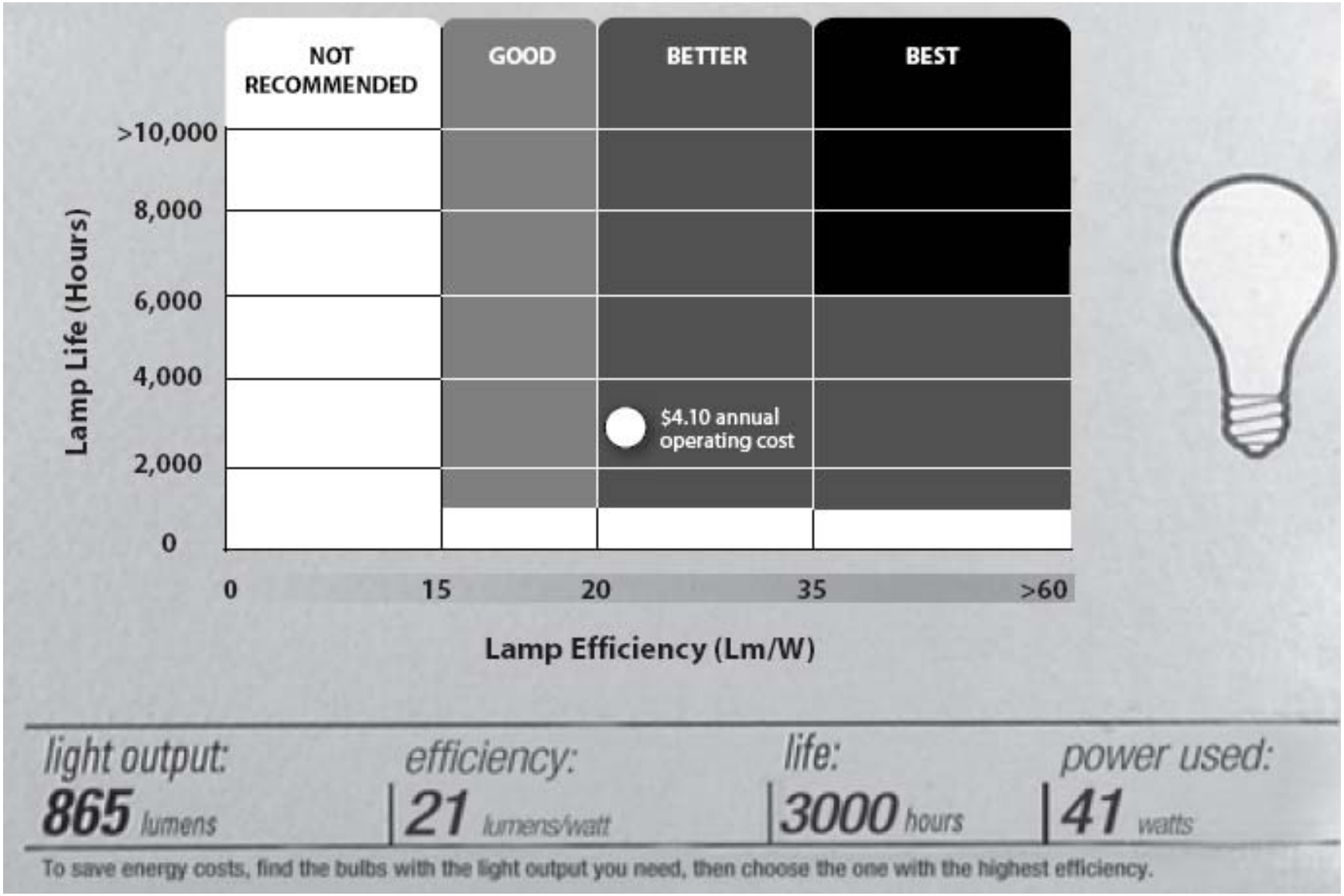

GENERAL PURPOSE
reveal® 60
clean, beautiful light™
ENHANCED COLOR SPECTRUM
light output: 630 lumens
energy used: 60 watts
life: 1000 hours
contains: 4 bulbs (A19)


GENERAL PURPOSE
HALOGEN
2 YEAR BULB
edison™ 60
bright, crisp light™
long life bulb*
ampoule longue durée*
coated bulb reduces glare
ampoule enduite, moins éblouissante
light output: 840 lumens
energy used: 60 watts
life: 3000 hours
contains: 1 bulb (BT/A)

Mandatory Energy Cost Labeling: Another Sensible Way to Drive Purchase Changes

- U.S. light bulb labeling currently requires three things:
  - Light output (lumens)
  - Power consumption (watts)
  - Lifetime (hours)
- Two more items should be required:
  - Yearly electric bill to operate the bulb (dollars)
  - Efficiency (lumens/watt)
- In addition, one other provision may be worth considering: that product wattage may not be given greater prominence in product packaging or marketing than light output or efficiency

Proposed Labeling Approach: de-emphasize lamp wattage. Help buyers shop by light output, efficiency, lamp life, and operating cost instead.



Suggested Objectives of Future Policies and Programs

- Align manufacturers' and retailers' profit-making objectives with the broader societal objective of stabilizing the climate. Their natural desire to make a profit should, under your policies, lead them to produce products radically more energy efficient and long-lasting than today's products. Two ways to achieve that: rebates for selling efficient products and fees on the sale of inefficient ones. One can help pay for the other.
- Assign a meaningful economic value to saving CO_2 and include it in the definition of "cost-effective efficiency."
- Establish simple, transparent, broadly applicable standards that become more stringent soon, while also charting a long term technology "roadmap" for manufacturers to minimize uncertainty.
- Capture as much cost-effective energy and carbon savings as possible, while minimizing loopholes and gaming.
- Arm consumers with new information that will help them escape the trap of confusing power consumption (watts) with performance (lumens) or efficiency (lumens/watt).